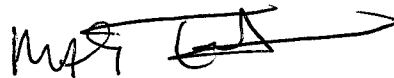


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A handwritten signature in black ink, appearing to read 'MAJ Torres', with a long horizontal line extending to the right.

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Date: **13 June 2016**

**Uniformed Services University
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Manuscript/Presentation Approval or Clearance


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Prevalence of the middle mesial canal in non-surgical root canal treated mandibular first and second molars in a local military population.

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Disclaimer

The views expressed in this abstract/manuscript are those of the author(s) and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the US Government.

ABSTRACT

Introduction: The internal anatomy of the mesial root of the mandibular first and second molar is highly complex. Literature supports a variety of canal presentations ranging from 1 canal to multiple canals. The presence of a third canal called the middle mesial canal (MM) is well documented. The MM canal can go undetected unless the clinician is careful to identify it. Missing this canal can contribute to a sequelae of persistent disease that may require the retreatment of the tooth or extraction of a tooth when the infection is unresolved. **Null hypothesis:** There is no difference in prevalence of a middle mesial canal between a younger patient and an older patient, or between males and females. **Objective:** This longitudinal study evaluates the prevalence of middle mesial (MM) canals in mandibular first and second molars in a local military population and correlates the findings with age, sex, and molar type. **Methods:** 7000 dental records were reviewed for non-surgical root canals performed from October 1970 to October 2015. The data collected included patient sex, age of the patient at the time of treatment, tooth number, and number of mesial and distal canals. The statistical analysis included: chi-square, Fisher exact tests, and nonparametric Wilcoxon rank sum test, and logistic regression models. **Results:** This study analyzed 422 mandibular first molars and 102 mandibular second molars that were treated between October 1970 to October 2015. 11 MMs canals were identified. Interestingly, MM canals only occurred in 1st molars and only after 2011. The prevalence of the MM was 4.3% after 2011. MM were found more frequently in the 40+ age group and in females ($p < .05$). **Conclusion:** The overall rate was 4.3% and is lower than other studies. Patients older than 40 and female patients are more likely to have a middle mesial canal but association is not strong due to low prevalence of MM.

Introduction

The mesial root of the mandibular first and second molar is highly complex and literature supports a variety of canal presentations ranging from 1 canal to multiple canal^{2,3,11,14}. Traditionally, the mesial canal is described as having 2 canals¹.

The prevalence of the middle mesial canal is historically low but is well documented in publications and case reports^{1,9,10}. A patent MM canal may go untreated and can contribute to the chronicity of periapical pathology and its sequelae unless the clinician is careful to identify it^{4,6,12}.

This purpose of this study was to investigate the prevalence of the middle mesial canal in nonsurgical root canal therapy in a local military population and to correlate the prevalence of MM canals with molar type (1st or second mandibular molar), sex, and age.

Materials and Methods

Approximately 7, 000 dental records in paper chart format were reviewed at a military dental clinic, with dates ranging from October 1970 to October 2015 in order to locate non-surgical root canal treatments in mandibular first and second molars. The protocol followed was exempt by the Institutional Review Board at Tripler Army Medical Center.

To ensure records were randomly chosen and that no records were duplicated, an online random generator was used.

Data without any personally identifiable information was recorded on an Excel spreadsheet and maintained on a secured computer in the dental clinic. Access to research records was restricted to authorized research personnel only.

The data collected included patient sex, age of the patient at the time of treatment, tooth number, and number of mesial and distal canals.

The chi-square and Fisher exact test were used to determine the differences in the prevalence of MM canals. The nonparametric Wilcoxon rank sum test was used to evaluate the influence of age. Estimated unadjusted and adjusted odds ratios were prepared based on logistic regression models.

Results

This study documents 422 mandibular first molars and 102 mandibular second molar nonsurgical root canal treatments performed from October 1970 to October 2015. 11 MM canals were found, occurring only in 1st molars, and only after 2011. Since no MM canals were found in first molars prior to 2012 or in second molars, this data was excluded due to its low significance.

After 2011, 255 1st molar NSRCTs were documented, mainly in male patients. The prevalence rate of MM was 4.3% ($p=0.011$, 95% confidence interval = 2.2%-7.6%). There is an increased prevalence of MM canals in women compared to men (10.5% vs. 3.2% when restricted to years after 2011, $p=0.064$ unadjusted and $p=0.03$ when adjusted for age). Age is moderately higher for patients with 3 mesial canals compared to patients with fewer canals based on nonparametric Wilcoxon rank sum test ($p=0.057$ and $p=0.050$ for all first molars and all first molars after 2011).

The adjusted odds ratio (OR) for females relative to males is 4.69 ($p=.026$), and the adjusted OR for patients 40+ compared to patients 18-24 is 9.86 ($p=.024$). The adjusted OR for a 10 year age difference (e.g., 40 year old vs. 30 year old, or 30 year old vs. 20 year old) is 2.76 ($p=.010$).

There is no association between the number of mesial canals and distal canals.

Discussion

The overall MM prevalence rate of 4.3% after 2011 in 1st molars and 0% in 2nd molars is low compared to more current studies. Nosrat reports 22% rate in 1st Molars and 16% in 2nd molars. Azim reports 37.5% in 1st molars and 60% in 2nd molars^{9,10}.

Prevalence of MM canal findings in other studies					
Author/Year	Overall rate (%)	# of MM canals	# of teeth studied	Rate in 1 st Molar	Rate in 2 nd Molar
Skidmore ¹ 1971	0	0	45	0	0
Pomeranz ¹⁴ 1981	12	12	100	12	0
Kim ⁴ 2013	0.3	5	1435	.3	0
Nosrat ¹⁰	20	15	75	22	16

2015					
Azim ⁹ 2015	46	42	91	37.5	60
Current Study	4.3	11	522	4.3	0

A younger age is significant in all other studies^{9,10}. However in this study, a MM canal is likely to be discovered as part of root canal re-treatment therapy at a later age, thus explaining a greater prevalence for age 40+. Possible reasons for lack of MM canal discovery before 2012 may be due to not looking for a MM canal, not using dental microscope routinely, lack of awareness, or lack of knowledge of a particular technique for uncovering MM canal^{7,9}. This study identified that the majority of MM canals were found by endodontists who may be more likely to look for a MM canal and use a dental operating microscope. It is likely the MM canal can be missed without the use of microscopes. In this study less than 5 providers annotated the use of the microscope, even though a microscope is used routinely by many providers and suggests a lack of consistency of documenting when the microscope is used.

As of fiscal year 2014, the United States Armed forces was comprised of 84.9% males and 15.1% females⁸. The patient population was similar in this study: 83.4% males and 16.6% females. In this study, MM canals occurred at higher rate in females but this finding is not very significant due to the low number of female patients.

In this study age of 40+ is an explanation for a greater likelihood of finding MM canals. This is likely due to the fact that root canal retreatments are done on an older patient at a higher rate in the local army population. More data is needed to confirm the validity of this finding.

The name of Middle mesial canal does not describe whether a patent third canal exists. Pomeranz notes that a truly patent canal occurs less than 1 percent of the time¹⁴. Most of the time, the middle mesial canal joins with the lingual or buccal canal at the apex. This explains the high success of the molar root canal despite not locating the middle mesial canal. However, missing a canal can lead to continued pain and discomfort to the patient and other sequelae that may require nonsurgical retreatment, or surgical retreatment, or ultimately lead to the extraction of the tooth. In the case of an extraction, a patient may elect an implant or a fixed dental denture. Implants are highly successful but a patient may still succumb to implant failure. Fixed partial denture preparations can cause an abutment tooth to require root canal procedures at a rate of 10%¹³.

Conclusion

In this study, middle mesial canals were found in only first molars, and only after 2011. The overall rate was 4.3% and is lower than other studies.

The data suggest an age (40+) and sex (female) effect but the exact relationship cannot be determined without more data due to the low prevalence of MM canals in these patients.

Practitioners should search for the middle mesial canal to prevent post-root canal infections. The use of a dental operating microscope can help identify the middle mesial canal.

References

1. Skidmore A, Bjorndal A . Root canal morphology of the human mandibular first molar. *Oral Surg* 1971; 32 (5):778-784.
2. Vertucci F, Williams R. Root canal anatomy of the mandibular first molar. *J NJ Dent Assoc.* 1974; Spring:27-28.
3. Weine F. endodontic therapy. 2nd edition; St. Louis, C. V. Mosby Co, 1976, p 334.
4. Kim SY, Kim BS, Woo J, Kim Y. Morphology of mandibular first molars analyzed by cone-beam computed tomography in a Korean population: variations in the number of roots and canals. *J Endod* 2013;39:1516–21.
5. Baldassari-Cruz LA, Lilly JP, Rivera EM. The influence of dental operating microscope in locating the mesiolingual canal orifice. *Oral Surg Oral Med Oral Pathol*
6. Toure B, Faye B, Kane AW, et al. Analysis of reasons for extraction of endodontically treated teeth: a prospective study. *J Endod* 2011;37:1512–5.
7. Selden H. The dental-operating microscope and its slow acceptance. *J Endod* 2002; 28 (3): 206-207.
8. 2014 Demographics. Profile of the military community. Office of the Deputy Assistant Secretary of Defense. 2014;18-20.
- 9 Azim A, Deutsch A, Solomon C. Prevalence of middle mesial canals in mandibular molars after guided troughing under high magnification: an in vivo investigation. *J Endod* 2015; 41(2): 164-167.
10. Nosrat A, et al. Middle mesial canals in mandibular molars: incidence and related factors. *J Endod* 2015; 41 (1): 28-32.
11. Ballulaya S. Variable permanent mandibular first molar: review of literature. *J Con Dent* 2013;Mar/Apr (2): 99-107.
12. Nair PN, Sjogren U, Krey G, et al. Intraradicular bacteria and fungi in root-filled, asymptomatic human teeth with therapy-resistant periapical lesions: a long-term light and electron microscopic follow-up study. *J Endod.* 1990;16:580.
13. Valderhaug J, Jokstad A, Ambjornsen E, Norheim PW. Assessment of the periapical and clinical status of crowned teeth over 25 years. *J Dent.* 1997;25:97

14. Pomeranz H. Treatment consideration of the mandibular first and second molars.
1981; 7(12):565-568